

Ontario Geological Survey

Northern Ontario Engineering Geology Terrain Study 26

MOUNT ROYAL AREA

(NTS 52H/NE)

District of Thunder Bay

D.G. Mollard and J.D. Mollard

1981



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MAP (accompanying report)

Map 5050 (coloured) – Northern Ontario Engineering Geology Terrain Study,
Data Base Map, Mount Royal (NTS 52H/NE). Scale 1:100 000.



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MOUNT ROYAL AREA

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District of Thunder Bay

by

D.G. Mollard¹ and J.D. Mollard²

1.0 INTRODUCTION:

This report contains an inventory of regional engineering terrain conditions in the Mount Royal map-area, District of Thunder Bay. The area, which covers NTS block 52H/NE, lies between Latitudes 49°30'N and 50°00'N and Longitudes 88°00'W and 89°00'W. This report forms part of a series of publications which provide similar terrain data for some 370 000 km² of northern Ontario.

The purpose of the mapping is to provide a guide for engineering and resource planning functions at a level of detail consistent with a scale of 1:100 000. The terrain information is contained on the Data Base Map (OGS Map 5050, accompanying this report).

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Interpretation of black and white aerial photographs, at a scale of approximately 1:50 000, formed the basis of the terrain mapping process. The interpretation was checked against published and unpublished maps and reports which documented previous field visits and observations. During the fall of 1977, roads in the map-area were traversed and observed terrain conditions recorded as further verification of the office studies. Thus, the Data Base Map represents a reconnaissance overview of the engineering conditions of the terrain.

An engineering terrain legend was developed to facilitate the mapping and to provide a common information base for the entire map series. This legend is shown on the accompanying Data Base Map. Further discussion on the mapping techniques, legend format, and possible uses of this engineering geology information is available in the Ontario Engineering Geology Terrain Study Users' Manual (Gartner, Mollard, and Roed 1980), a companion publication to this series of maps and reports.

2.0 PHYSIOGRAPHY AND GEOLOGICAL SETTING:

The Mount Royal map-area lies within the James Region of the Precambrian Shield (Bostock 1967). The Nipigon Plain physiographic unit of this region, which surrounds Lake Nipigon, is underlain by Early Precambrian (Archean) metasediments and metavolcanics and essentially flat-lying Late Precambrian mafic sills. This plain is deeply dissected, with remnants of the resistant mafic sills standing out as widely scattered flat-topped hills with near vertical sides.

Land makes up only a small portion of this map-area, with the water of Lake Nipigon covering the remainder. Maximum elevations in excess of 412 m occur in the southeast corner of the map-area, on Kelvin Island in the northeast-central part, and south of Humboldt Bay in the northeast corner. Minimum elevations of 260 m occur near the shore of Lake Nipigon.

3.0 ENGINEERING TERRAIN UNITS:

The engineering terrain units mapped are identified in terms of four components: surface material, landform, topography, and drainage.

Format of the legend used in the terrain mapping is described in detail in the Users' Manual (Gartner, Mollard, and Roed 1980). Landform is a very important component because surface and near-surface materials, topographic expression, and the surface and internal drainage conditions are all related to it. Consequently, the engineering terrain units are grouped, for descriptive purposes, according to the dominant landform.

A particular landform can occur as the only component in a simple terrain unit. The dominant landform usually occupies more than half of a complex terrain unit. Where only one subordinate landform is shown, it usually occupies between 10 and 50 percent of the complex unit. Where two subordinate landforms are shown, the first covers the larger area. Landforms that occupy less than 10 percent of the terrain in a complex unit are rarely indicated in the terrain unit letter code. Where two or three landforms in a complex terrain unit consist of the same material, the landform letter symbols are connected by a dash. Examples of terrain unit letter codes which may occur in this map-area, and an explanation of each, are given in the Appendix.

A large number of complex terrain units has been mapped due to the widespread occurrence of irregular topography. Bedrock, which is situated at or near the ground surface throughout much of the map-area, controls the topography and therefore the surface drainage conditions. Resource development and engineering planning considerations are complicated by these complex conditions.

Noteworthy occurrences of important landforms are described with respect to location, typical materials, topography, and drainage; their significance in geotechnical investigations, regional engineering planning, and resource development is summarized.

3.1 BEDROCK PLATEAU (RL):

3.1.1 Description:

Areas mapped as bedrock plateau (RL) contain bold mesa-like features that have a capping of resistant rock consisting of eroded remnants of Proterozoic diabase sheets. The surface aspect of mesas and plateaus varies from nearly level to moderately sloping. Cliffs around part or all of these elevated features are strewn with coarse talus debris.

The surface of these landforms tends to be dry. Exceptions are the bottoms of long linear depressions. Usually these narrow trenches are partly filled with standing water or they contain organic deposits. Although bedrock plateau areas generally exhibit elevated planar slopes, they may still have knobby and jagged surfaces locally; these features can markedly affect engineering and construction costs.

The map user should note that this landform can occur in simple or complex terrain units (e.g. RL(MG/R)).

3.1.2 Occurrence:

Bedrock plateaus (RL) occur 1) on the peninsula which separates Grand Bay from McIntyre Bay, in the southwestern part of the map-area; 2) on the peninsula which separates Humboldt Bay from East Bay, in the northeastern part of the area, and 3) on the east shore of Lake Nipigon in Barbara Township.

3.1.3 Engineering and Planning Significance:

Construction costs are generally high because slopes are steep and the presence of bedrock often necessitates blasting. Because bedrock plateau areas are aesthetically very pleasing, the possibility of developing small acreages, ski slopes, and sight-seeing tours holds considerable promise in some localities. Cliffs may be unstable since they are subject to rock falls. Road construction can be extremely difficult and costly in areas where the bedrock is highly uneven and is situated at or very near the surface. On roadways, horizontal and vertical sight distances are generally low and can create a traffic hazard.

3.2 BEDROCK KNOB (RN):

3.2.1 Description:

Bedrock knob landscape (RN) is characterized by an irregular bedrock surface having complex multiple slopes of varying steepness. The cover of glacial deposits overlying the bedrock knobs is generally thin and discontinuous. Much of the glacial overburden consists of bouldery, sand-rich till that was transported only a short distance by the ice.

3.2.2 Occurrence:

Bedrock knob (RN) terrain is widespread in the Mount Royal map-area. In most cases, it occurs in complex association with other landforms, such as ground moraine (RN(MG)), or covered by a thin blanket of ground moraine (MG/RN). Many of the islands in Lake Nipigon are bedrock knobs. A large rock knob unit is located in and north of Meader and Barbara Townships on the eastern margin of the map-area.

3.2.3 Engineering and Planning Significance:

Two principal engineering considerations are the large volumes of rock that must be excavated during construction and the generally uniform and solid foundation conditions at shallow depths. However, due to difficult topography and the existence of rock fractures, bedrock knob terrain is considered poor for most types of light construction and for waste disposal. Drilling and blasting are required during the construction of almost all types of engineering works.

3.3 BEDROCK RIDGE (RR):

3.3.1 Description:

The bedrock ridge unit (RR) consists of long, narrow, subparallel and intersecting bedrock ridges of varying height. Thickness of drift over the masked bedrock surface varies substantially over short distances. In general, it is relatively thin (1 to 2 m) on ridge tops and thicker on the lower slopes and in the depressions between rock ridges.

3.3.2 Occurrence:

Bedrock ridges (RR) occur in and east of Kitto Township in the south-east corner of the map-area, on Shakespeare, Alexandra, Dawson, and Caribou Islands in Lake Nipigon, and north of Nazoteka Point, on the western margin of the area. Underhill Mountain in the northwest corner of the area is also a bedrock ridge.

3.3.3 Engineering and Planning Significance:

The main construction problem is the large quantities of very hard rock that often must be excavated during construction. Drilling and blasting

costs can be very high. Bedrock ridge terrain is considered poor for most types of engineering, construction, and resource development. It also has a low rating for waste disposal due to irregular relief, the presence of rock fractures near the ground surface, and the high cost of earthwork construction.

3.4 GROUND MORaine (MG):

3.4.1 Description:

The term "ground moraine", (MG) refers to an extensive deposit of till forming an undulating to rolling plain. Although till is generally composed of an assortment of particle sizes (including clay, silt, sand, gravel, cobbles, and boulders), till deposits in this map-area have a high sand and boulder content. The thickness of till in ground moraine varies from less than 1 m to many tens of metres. The landform is mapped as MG where the till is thick enough to mask any topographic effect of underlying bedrock. In general, the till layer forms a mantle less than 3 m thick over the bedrock and is mapped as MG/R. Till in ground moraine tends to be thicker in bedrock depressions and thinner over bedrock ridges and knobs.

3.4.2 Occurrence:

Ground moraine (MG) is widespread throughout the Mount Royal map-area, generally as a veneer over bedrock (MG/R) or in complex association with bedrock terrain (MG(R)). The largest expanse of ground moraine occurs on the west shore of Lake Nipigon, in the southwestern part of the map-area.

3.4.3 Engineering and Planning Significance:

The till in ground moraine is coarse and bouldery, and has moderate permeability and internal drainage, low compressibility, and high bearing strength. Water table position varies with relief, being lower beneath knolls and low ridges, and higher beneath depressions. The till in many of the depressions is covered by thin deposits of peat and muck.

The suitability of ground moraine for road and other light foundation construction is fair to good. The fact that the till often forms only a thin

mantle over the bedrock (MG/R) has a great deal of significance in road building. Road construction through this type of terrain is difficult owing to the bouldery nature of the till and the probability of encountering bedrock in cuts. The suitability of ground moraine for waste disposal varies from poor to fair.

3.5 ICE-CONTACT DELTA (GD):

3.5.1 Description:

Esker deltas, kame deltas, and delta moraines are all varieties of the ice-contact delta. Some are quite large in area and important in terms of the volume of recoverable sand and gravel which they contain. Individual beds, consisting mainly of sand or gravel, are usually better sorted, cleaner, and less variable than stratified deposits in esker (GE) and kame (GK) landforms. The beds in this unit are also typically less folded and faulted and are more continuous. It is worth noting that materials in many ice-contact deltas are coarse (i.e. gravelly) on the north and northeast sides and finer (i.e. sandy) on the south and southwest sides. These conditions indicate the parts of the delta which were, respectively, closest to and farthest from the glacial front against which the delta was built.

3.5.2 Occurrence:

A large ice-contact delta, located in the northwest corner of the map-area, was formed by meltwaters flowing into Glacial Lake Kelvin (Zoltai 1965a). Smaller delta units occur on Kelvin Island, in the central part of the area, and on the peninsula which forms the eastern side of McIntyre Bay, on the southern margin of the area.

3.5.3 Engineering and Planning Significance:

Ice-contact deltas are good potential sources of concrete and blacktop aggregate. They are also favorable sites for the construction of airstrips, roads, and other types of engineering works. Because the subsoils are highly permeable, deltaic (GD) landforms are relatively poor areas for waste disposal. Larger deposits, however, are generally good ground water prospects, especially where sand and gravel horizons are thick and extend below the water table. Ice-contact deltas possess high bearing strength and good workability in wet weather. Slopes are stable and subsoils are well

drained. Away from the steeply sloping margins of this landform, earth-work volumes and excavation costs are normally low. Reservoirs and sewage lagoons in ice-contact deltas must be lined to prevent excessive leakage.

3.6 GLACIOLACUSTRINE PLAIN (LP):

3.6.1 Description:

Sediments in glaciolacustrine plains consist of varved and massive, fine-grained materials deposited in glacial lake basins of varying size and depth. The proportions of clay, silt, and sand deposited at any particular location in these basins varies with depth of water in the former lake, distance from former shorelines, and the size of particles washed into the lake. Most clay, silt, and sand lacustrine deposits contain minor inclusions of till and scattered dropstones which were rafted into the lake on pieces of ice. In places, wave and current action in former glacial lakes eroded the surface of till deposits, producing thin patches of washed sand, gravel, and boulders that rest on till or bedrock. In other areas, bedrock knobs and ridges are surrounded by pockets of glaciolacustrine sediment. Glacial lake deposits usually consist of clay and silt (cLP, cmLP, mcLP) which accumulated in deep offshore waters at a depth where the bottom was no longer affected by wave action (generally below 10 m). Closer to shore, and at points where rivers discharged sandy materials into the lake, the deposits usually consist of fine and medium sand with minor silt (sLP, smLP). Most of these sandy lacustrine deposits accumulated in deltaic environments.

3.6.2 Occurrence:

Glaciolacustrine plain deposits underlie the lowlands surrounding Lake Nipigon and also occur on some of the islands in the lake. The largest units occur 1) north of Black Sturgeon Bay and north of Gull Bay, on the western margin of the map-area and 2) in Dorothea and Sandra Townships and Eva and Kitto Townships, on the eastern margin.

3.6.3 Engineering and Planning Significance:

Glaciolacustrine clay deposits (cLP) have high water retention capacity, low permeability, and poor internal drainage. These characteristics are largely controlled by a network of closely spaced joints. Generally,

these landforms possess low density, low bearing strength, and moderate to high compressibility, unless the fine-grained sediments have been consolidated by the weight of overriding glacier ice or by the effects of desiccation. The clay sediments usually provide poor foundation conditions and can be difficult to work with heavy construction equipment during wet weather. Most clay plains in the map-area are level to gently sloping. The sides of river valleys which have been deeply incised into these fine deposits are frequently highly dissected and are susceptible to rill-and-gully erosion on freshly cut ditch slopes and highway back slopes. Higher and steeper natural and man-made slopes are subject to the development of small failures. Where these lacustrine materials carry a high proportion of silt or very fine sand, they are susceptible to frost heave and the formation of frost boils. Subsoil permeability ranges from low to nearly impervious; as noted above, this is largely dependent on the presence of a system of closely spaced joints. In locations where glaciolacustrine clay sediments are highly plastic, they have a tendency to shrink or swell with changes in moisture content. Bearing capacity, shear strength, and compressibility vary greatly with differences in previous loading history and, therefore, the natural moisture content. Bearing capacities can be low in wet areas, particularly where plastic clay soils are normally consolidated or only slightly consolidated.

Low-lying clay plains have a high water table and are subject to local flooding during spring runoff and heavy cloudbursts. During wet weather, the glaciolacustrine clay sediments have poor workability characteristics for building roads and structures. This landform usually provides good sites for waste disposal because of its low permeability.

Lacustrine sand plains (sLP) contain mostly fine and medium sand with minor silt. Coarse sand, gravel, cobbles, boulders, and till are rare in these deposits. Sand plains are gently sloping to undulating and are well drained. A high water table may occur at sites located some distance from the ground water lowering effects of deep valleys and ravines. Sandy lacustrine materials are typically nonplastic and have high permeability, low compressibility, moderate to high bearing capacity, and high shear strength. They are generally not frost susceptible unless they contain significant amounts of silt and very fine sand. They represent fair to good terrain for most construction, especially that of roads and airstrips. They are poor for waste disposal due to the possibility of effluent seepage and ground water contamination.

3.7 SAND DUNES (ED):

3.7.1 Description:

Dunes are composed of fine and medium sand that has been blown into ridges by wind action. Dune ridges range in height from 1 or 2 m to more than 5 m, and may be long, narrow, and either straight, arrowhead, or arcuate in plan view. Dunes usually overlie or occur downwind from sandy outwash plains and sandy glaciolacustrine plains.

The location of sand dune areas may also be indicated on the map by the graphic symbol (see ).

3.7.2 Occurrence:

A belt of sand dunes, approximately 2 km in width, extends east-north-east from the shore of Lake Nipigon through Eva, Dorothea and Sandra Townships to the eastern margin of the map-area.

3.7.3 Engineering and Planning Significance:

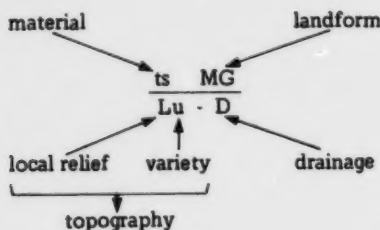
Sand dunes possess special characteristics of engineering significance. When denuded of vegetation, the fine and medium sand in dune ridges is susceptible to wind erosion and drifting. A moderate to low water table can be expected beneath higher dune ridges. Dunes are well drained, and the sand of which they are composed has a low strength when it is not confined. These deposits usually have low compressibility unless sand of a relatively uniform grain size has been deposited in a very loose state. Where dune sand is loose, generally beneath the slip face, it may possess a moderate to low relative density. The bearing strength of dune material is also low where the sand is unconfined, but can increase with the degree of confinement. Caving of wet and dry sand in vertical ditch walls is a potential problem which can increase costs on major construction jobs. Dune sand is nonplastic and is generally not susceptible to frost action or shrinking and swelling. Most dune deposits provide a good source of sub-base material for highway pavement structures. Where the underlying sub-grade has a high water table, only relatively clean dune sands should be used.

4.0 APPENDIX: EXAMPLES OF TERRAIN UNIT LETTER CODES:

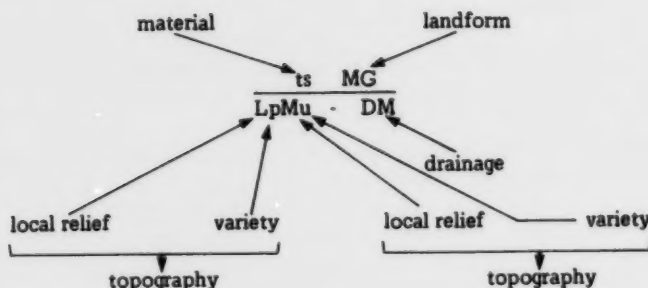
The engineering terrain unit letter codes consist of four components: surface materials, landform, topography, and drainage. The format of the letter codes used in describing the terrain units is discussed in detail in the Users' Manual (Gartner, Mollard, and Roed 1980). Some additional examples of the letter codes are as follows:

4.1 SIMPLE TERRAIN UNIT:

Example 1:



Example 2:

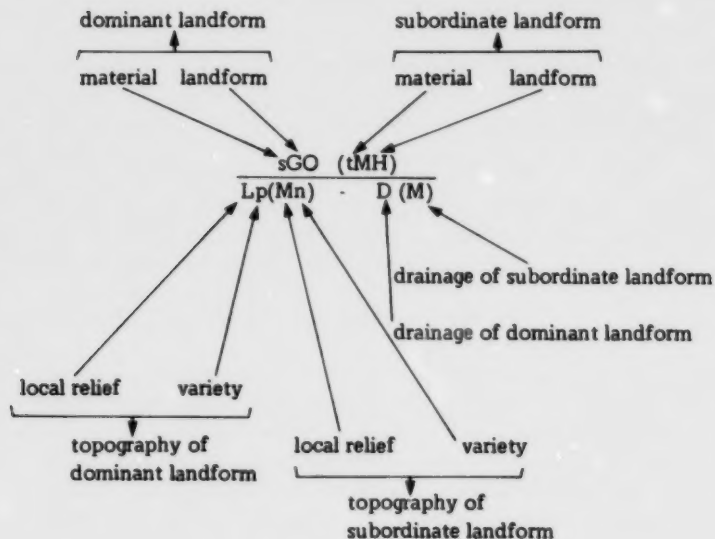


Note: The above type of letter code is used where there are two distinctly different types of topography and/or drainage in a simple terrain unit.

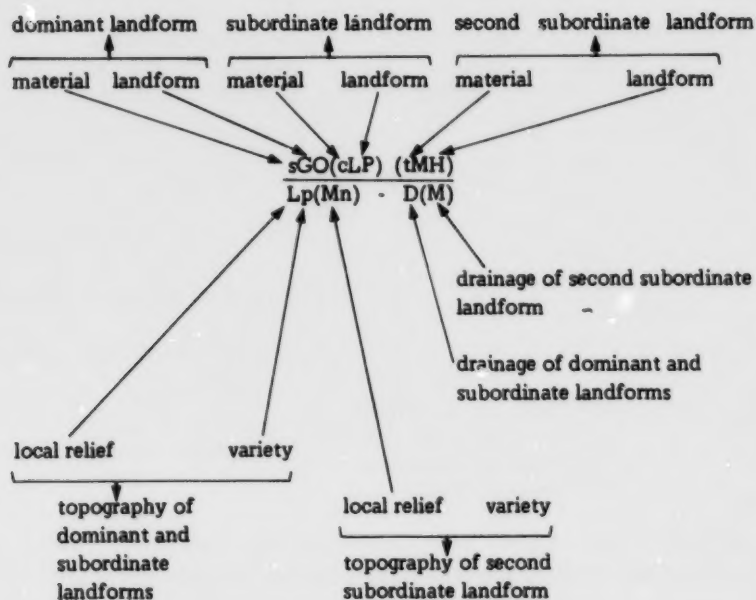
4.2 COMPLEX TERRAIN UNIT:

In complex areas, the dominant landform is shown first and the subordinate landform(s) appear in parentheses.

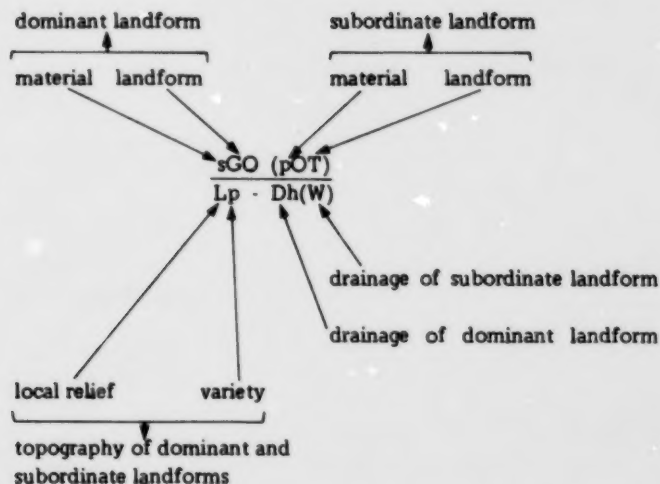
Example 1:



Note: The topography and drainage in parentheses refer to the landform shown in parentheses.

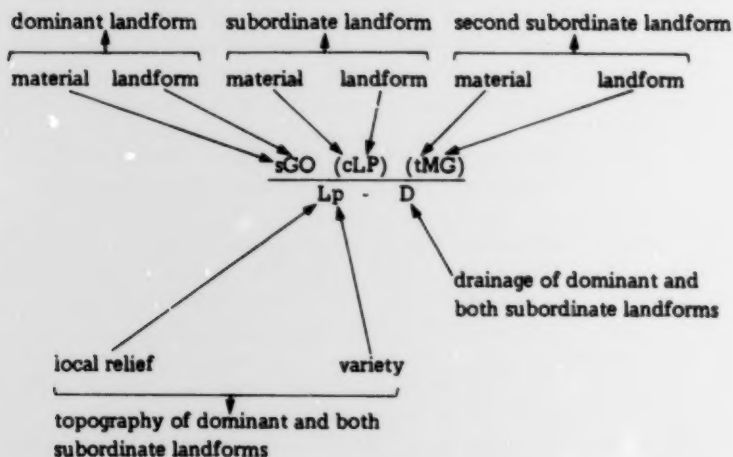
Example 2:

Note: The topography and/or drainage in parentheses refer to the second subordinate landform (in parentheses).

Example 3:

Note: If topography or drainage is similar in the dominant and subordinate landforms, then no topography or drainage symbol is shown in parentheses and the symbol shown applies to both landforms. If topography or drainage conditions are different in one of the landforms, a topography or drainage symbol is shown in parentheses to indicate this difference.

Example 4:



Note: Where topography and drainage conditions are similar in all of the landforms shown, no topography or drainage symbols are placed in parentheses.

5.0 REFERENCES:

Bird, J. Brian

1972: *The Natural Landscapes of Canada - A Study in Regional Earth Science*; Wiley Publishers of Canada Limited, Toronto, 191 p.

Bostock, H.S.

1970: *Physiographic Regions of Canada*; Geological Survey of Canada, Map 1254A, scale 1:5 000 000. Compilation 1967.

Canada Department of Agriculture

1972: *Soils of Canada*; Soil Research Institute, Research Branch, Canada Department of Agriculture, scale 1:5 000 000.

Coates, M.E.

1972: *Geology of the Black Sturgeon River Area, District of Thunder Bay*; Ontario Department of Mines and Northern Affairs, Geological Report 98, 41 p. Accompanied by Maps 2233 to 2236, scale 1:63 360 or 1 inch to 1 mile.

Douglas, R.J.W.

1969: *Geological Map of Canada*; Geological Survey of Canada, Map 1250A, scale 1:5 000 000. Compiled 1966, 1967.

Farrand, W.R.

1960: *Former Shorelines in Western and Northern Lake Superior Basin*; unpublished Ph.D. thesis, University of Michigan, Ann Arbor, 226 p.

Fremlin, Gerald (editor)

1974: *The National Atlas of Canada, Fourth Edition (Revised)*; MacMillan Company of Canada Limited in association with the Canada Department of Energy, Mines and Resources and Information Canada, 254 p.

Gartner, John F., Mollard, J.D., and Roed, M.A.

1980: *Ontario Engineering Geology Terrain Study Users' Manual*; Ontario Geological Survey, Open File Report 5288, 99 p.

Gentilcore, R.L. (editor)

- 1972: *Studies in Canadian Geography: Ontario*; University of Toronto Press, Toronto, 126 p. (reprinted 1974).

Guillet, G.R.

- 1978: *Special Minerals: Clay and Marl Utilization in NTS 52H*; unpublished report for Gartner Lee Associates Limited, Toronto-Buttonville Airport, Markham, Ontario.

Hageraats, H.M.

- 1971: *Landscape and Site Development*; Design Branch, Canada Department of Public Works, 88 p.

Hills, G.A.

- 1961: *The Ecological Basis for Land-Use Planning*; Research Branch, Ontario Department of Lands and Forests, Research Report No. 46, 204 p.

Prest, V.K.

- 1969: *Retreat of Wisconsin and Recent Ice in North America*; Geological Survey of Canada, Map 1257A, scale 1:5 000 000. Compiled 1969.

Prest, V.K., Grant, D.R., and Rampton, V.N.

- 1968: *Glacial Map of Canada*, Geological Survey of Canada, Map 1253A, scale 1:5 000 000. Compiled 1964-1966.

Pye, E.G.

- 1968: *Geology and Scenery, Rainy Lake and East to Lake Superior*, Ontario Department of Mines, Geological Guidebook No. 1, 118 p.
- 1969: *Geology and Scenery, North Shore of Lake Superior*, Ontario Department of Mines, Geological Guidebook No. 2, 144 p. (Reprinted 1975).

Pye, E.G. and Harris, F.R.

- 1964: *Lake Nipigon Sheet, District of Thunder Bay*; Ontario Department of Mines, Preliminary Map P.257, Geological Compilation Series, scale 1 inch to 2 miles. Geological compilation 1964.

Pye, E.G., Harris, F.R., Fenwick, K.G., and Baillie, J.

- 1965: Tashota-Geraldton Sheet, Thunder Bay and Cochrane Districts; Ontario Department of Mines, Map 2102, Geological Compilation Series, scale 1:253 440 or 1 inch to 4 miles. Geological compilation 1964, 1965.

Rowe, J.S.

- 1972: Forest Regions of Canada; Department of the Environment, Canadian Forestry Service, Publication No. 1300, 172 p.

Saarnisto, Matti

- 1974: The Deglaciation History of the Lake Superior Region and its Climatic Implications; Quaternary Research, Vol. 4, No. 3, p. 316-339.
1975: Stratigraphical Studies on the Shoreline Displacement of Lake Superior; Canadian Journal of Earth Sciences, Vol 12, No. 2, p. 300-319.

Skinner, R.G.

- 1969: A Summary of the Quaternary Stratigraphy of Northern Ontario, Canada; University of Washington, Seattle, Washington.

Wilson, Alfred W.G.

- 1910: Geology of the Nipigon Basin, Ontario; Canada Department of Mines, Geological Survey Branch, Memoir 1, 152 p.

Zoltai, S.C.

- 1962: Glacial History of Part of Northwestern Ontario, Proceedings of the Geological Association of Canada, Vol. 13, p. 61-83.
1965a: Glacial Features of the Quetico-Nipigon Area, Ontario, Canadian Journal of Earth Sciences, Vol. 2, No. 4, p. 247-269.
1965b: Surficial Geology, Thunder Bay; Ontario Department of Lands and Forests, Map S265, scale 1:506 880 or 1 inch to 8 miles. Surficial geology 1958-1960.

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